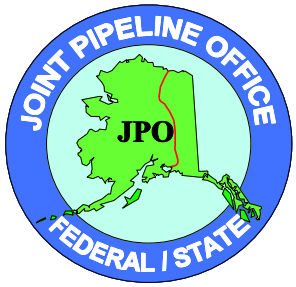

Evaluation of Alyeska Pipeline Service Company's Operation of the Trans-Alaska Pipeline System

Comprehensive Monitoring Program Report
February 1999

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Our Message to Stakeholders

TAPS and JPO

The Trans-Alaska Pipeline System (TAPS) transports nearly 20 percent of the nation's domestically produced crude oil through the unique and fragile environment of Alaska. TAPS is critical to the nation's business. Revenues and investment income from crude oil transported by TAPS account for 85 percent of the State of Alaska's general fund. Since start up in 1977, TAPS has safely transported more than 12 billion barrels of crude oil from Prudhoe Bay to Valdez. The Joint Pipeline Office (JPO), a unique consortium of six State and five Federal agencies, oversees Alyeska's management of TAPS.

JPO's Comprehensive Monitoring Program

JPO's vision is, *"To work proactively with the oil and gas industry in Alaska to achieve safe operation, environmental protection, and continued transportation of oil and gas in compliance with legal requirements."* The JPO Comprehensive Monitoring Program (CMP) is intended to influence continuous improvement in Alyeska's management of TAPS construction, operations and maintenance activities. The JPO CMP process is focused on problem prevention rather than reaction, emergency response, and damage control.

CMP reports periodically communicate to JPO stakeholders summaries of past significant findings, conclusions and recommendations drawn from JPO monitoring efforts. They revisit critical TAPS audit deficiencies; incorporate concerns raised by TAPS employees and outside interest groups; address high risk activities; verify compliance with laws, regulations, permit conditions, and Grant/Lease stipulations; verify compliance with important internal Alyeska controls such as the quality, safety and environmental programs; and evaluate causal factors and trends related to recent TAPS incidents. Each report covers one of twelve CMP functional topics and addresses a selection of significant issues of concern to JPO and its stakeholders:

Alaska Native Employment & Training	Environment	Project Performance
Configuration Management	Maintenance	Quality
Employee Concerns Program	Safety	Risk Management
Equal Employment Opportunity	Project Design	Operations

Two additional CMP reports, Risk Management and Maintenance are nearing completion. Next year, the 12 categories will be consolidated into four CMP reports: Operations, Maintenance, Construction/Termination and Culture Change. Nevertheless, the emphasis of the CMP will remain unchanged. Coverage of environment, safety, quality, risk and configuration management will be addressed in each report.

About This Report

The JPO is pleased to present this evaluation of *Alyeska Pipeline Service Company's Operation of TAPS* to our stakeholders. While the operation and maintenance of TAPS will never be risk-free, JPO oversight will help minimize environmental risks and maximize compliance with worker safety and pipeline integrity standards.

Jerry Brossia	**William G. Britt, Jr.**
Authorized Officer	**State Pipeline Coordinator**

LIST OF ACRONYMS

AAI	**Audit Action Item**
AIMS	**Alyeska Integrity Management System**
ACT	**Audit Compliance Tracking and Closure**
ADEC	**Alaska Department of Environmental Conservation**
ADNR	**Alaska Department of Natural Resources**
AO	**Authorized Officer**
APSC	**Alyeska Pipeline Service Company**
BCS	**Backbone Communication System**
BLM	**Bureau of Land Management**
BVCS	**Block Valve Communication System**
CAR	**Corrective Action Request**
CDM	**Corrosion Data Management**
CFA	**Causal Factor Analysis**
CFR	**Code of Federal Regulations**
CMP	**Comprehensive Monitoring Program**
CP	**Cathodic Protection**
CRO	**Control Room Operator**
DO-14	**Trans-Alaska Controller Operating Manual**
DOI	**Department of Interior**
DOP	**Department Operating Procedure**
DOT	**Department of Transportation**
DSMA	**Digital Strong Motion Accelerometer**
ECP	**Employee Concerns Program**
EDM	**Engineering Data Management**
EMS	**Earthquake Monitoring System**
FGL	**Fuel Gas Line**
FOC	**Fiber Optic Cable**
JPO	**Joint Pipeline Office**
LEFM	**Leading Edge Flow Meter**
LVB	**Line Volume Balance**
MAOP	**Maximum Allowable Operating Pressure**
MLU	**Main Line Unit**
MLR	**Main Line Refrigeration**
MOC	**Management of Change**
MP-166	**System Integrity Monitoring Program Procedures Manual**
MP	**Milepost**
NCR	**Non-Conformance Report**
NTP	**Notice to Proceed**
OM-1	**Procedural Manual for Operations, Maintenance and Emergencies**
OCC	**Operations Control Center**
OSCP	**Oil Spill Contingency Plan**
PIC	**Pressure Indicating Controller**
PIP	**Principal Implementing Procedure**
PLMP	**Pipeline Milepost**
PM	**Preventive Maintenance**
PS	**Pump Station**

QA	**Quality Assurance**
QA-36	**Alyeska Quality Program Manual**
QDP	**Qualification and Development Program**
QI	**Qualification Instrument**
QTC	**Quality Technology Company**
RGV	**Remote Gate Valve**
ROW	**Right of Way**
SA-38	**Corporate Safety Manual**
SCADA	**Supervisory Control and Data Acquisition**
SPCO	**State Pipeline Coordinator**
TAPS	**Trans-Alaska Pipeline System**
TAS	**Training Administration System**
TVB	**Transient Volume Balance**
UCP	**Unit Control Panel**
VMT	**Valdez Marine Terminal**
Y2K	**Year 2000 Compliance**
WO	**Work Order**

Executive Summary

The Joint Pipeline Office (JPO) conducted field surveillances and assessments in 1997 and 1998, to evaluate selected aspects of Alyeska Pipeline Service Company's operation of the Trans-Alaska Pipeline System (TAPS). This report explains the issues which were addressed, describes their current status, and identifies instances of noncompliance with the Federal Agreement and Grant and State Lease of Right-of-Way. This report's conclusions will not surprise Alyeska. To their credit, Alyeska's own audits and surveillances have identified these concerns and corrective action is underway. In 1999, JPO will continue to oversee Alyeska's TAPS Operation Program, including compliance with the stipulations of the Grant and Lease, to determine Alyeska's effectiveness in resolving these issues.

Principal Conclusions About Pipeline Operations

- Five of the sixteen stipulations JPO evaluated were in noncompliance with the Grant and Lease. The noncompliances relate to change management and below ground systems deficiencies. The issues vary in significance, however none of them represent an immediate threat to pipeline integrity, public safety, or the environment. Alyeska has been informed all noncompliances must be corrected, and is working to bring them into compliance. JPO will evaluate progress and verify all completed corrections.

- Alyeska does not have an effective change management process and has failed to maintain complete and up-to-date records on pipeline system modifications as required by Stipulation 1.18.3. Change is inherent in the operation of TAPS due to technology advances, equipment deterioration, and modifications to improve cost efficiency. Pipeline system changes often have ramifications beyond the physical replacement of equipment that Alyeska's change management processes have not anticipated.

- Alyeska's management of the movement of oil needs greater attention to detail, better trending and evaluation of incidents, and more rigorous procedural compliance. JPO will verify implementation of proposed corrective actions.

- New leak detection technology has the potential to improve Alyeska's ability to promptly detect and respond to small, slow oil leaks within the pipeline system. Alyeska is reviewing the latest technology for leak detection, which JPO strongly encourages. Alyeska's new transient volume balance system is an improvement, but needs a comprehensive performance evaluation now that start up problems are resolved. JPO incorporated this request as a condition of approval of Alyeska's oil spill contingency plan. Improving leak detection will remain a top priority for oversight.

Additional Observations and Conclusions

- Alyeska needs to better trend and evaluate unscheduled pipeline shutdowns to identify any causes not fixed by the planned fiber optic system improvements.

- Alyeska did not consistently follow their quality control procedures for calibrating and maintaining pressure control devices and documenting the results. Corrective action plans have been implemented to fix this problem, including a plan to increase surveillance of tracking and controlling pressure relief system devices to prevent these

problems from recurring.

- A TAPS cold re-start study must first be completed before developing a new plan that includes procedures for re-starting the pipeline under extreme cold conditions after an extended shutdown. Study results will reveal information about system performance in the event of an extended shutdown.

- JPO continues to monitor Alyeska's ongoing investigation of an overpressure event that occurred in August 1998. A preliminary Alyeska engineering review concluded that pipeline damage was unlikely. JPO recently obtained the pipeline pig data and is currently evaluating it to verify Alyeska's conclusion. An oversight priority is to ensure Alyeska implements preventive measures to minimize future occurrences.

- Employees controlling oil flow have received considerable training. However, Alyeska should complete its qualification and development program initiative and comply with its requirements for self-audit and team qualification plans. Further, Alyeska should revisit controller's training and research information needs to cope with changes in system configuration. JPO encourages Alyeska to make full use of its new pipeline control simulator and to critically evaluate its effectiveness.

- Alyeska closed many operations-related audit action items in 1996 and 1997. Presently, five audit items remain open that are planned for completion later this year. However, several items that should significantly improve operations have not yet been closed. Operational deficiencies such as ineffective change management continue to exist, which will, if uncorrected, cause the repeat of many 1993 audit deficiencies. The audit items including change management will not be closed until an effective change management system is in place.

- JPO evaluated two issues involving buried pipe and concluded that: 1) the pipe curvature at Mainline Refrigeration Site No. 2, near the Gulkana River, is not a pipeline integrity concern under current operational conditions; and 2) no intervention is needed at Salcha River to address pipeline curvature.

- JPO finds Alyeska's Y2K effort to be well planned and organized. Alyeska's late start may increase the cost of the Y2K program, however, JPO does not have concerns about its effectiveness.

- Alyeska is replacing their current backbone communication system with a new fiber optics system and new valve control units, with the intent to: 1) minimize incidents of communication lapses to remote gate valves; 2) decrease unplanned shutdowns, and 3) enhance pipeline system safety. JPO will verify the reliability and safety of the system, once it becomes operational.

- Alyeska processed and closed two substantiated employee concerns related to operations in 1997-1998. JPO reorganized its employee concerns oversight to better trend and evaluate the concerns of TAPS workers.

Chapter 1. Purpose, Scope, Methods and Background

This report is the sixth in a series of Comprehensive Monitoring Program (CMP) reports designed to provide stakeholders with a view of how TAPS is operated and maintained. Previous CMP reports have covered safety, environment, project performance, Alaska Native utilization, and the employee concerns program. This report explains JPO's approach to situations when pipeline system integrity and safety are in question.

Purpose

All CMP reports evaluate compliance with relevant regulations and the Federal Agreement and Grant and the State Lease of Right-of-Way. The 30-year Federal Grant and State Lease for TAPS are scheduled for renewal by January 2004, therefore systematic compliance monitoring is a central purpose of the CMP. The intent of this report is to:

1) Report to the public and higher authorities about Alyeska's management of moving oil from
Prudhoe Bay to the Valdez Marine Terminal, and JPO's oversight of pipeline operations.

2) Describe the status of system integrity concerns such as Salcha River pipe curvature and the Mainline Refrigeration Site No.2 permafrost thawing problem.

3) Explain concerns regarding Alyeska's difficulty in controlling and managing system modifications. Change management will be further discussed in upcoming CMP Reports.

4) Discuss system modifications relating to fiber optics, valve communication, leak detection and Year 2000 computer compliance, and oversight of these initiatives.

5) Identify Federal Grant and State Lease compliance issues identified through JPO's monitoring of TAPS operations.

6) Evaluate significant issues raised by TAPS workers and take another look at key deficiencies identified in the 1993 TAPS audits.

Scope

The report scope includes JPO oversight of TAPS operations from June 1997 through September 1998. The report focuses on activities integral to the safe operation of the Trans-Alaska Pipeline System, with the scope limited to pipeline system operations of moving oil from Prudhoe Bay to the Valdez Marine Terminal. It also contains information from Alyeska's internal audits, which provide insight into the adequacy of Alyeska's approach to TAPS operations. Also included are

shutdowns related to communication failures that occurred from 1994 through 1998.

Since TAPS operation has a broad spectrum, this report does not evaluate all aspects of pipeline system operation. JPO selected areas for monitoring that were problem oriented, placing a heavy oversight emphasis on unscheduled shutdowns and pipeline restarts. This CMP report was chosen as the vehicle to report on the monitoring of pipeline integrity issues such as the Salcha River pipe curvature and Mainline Refrigeration Site No.2.

Methods

Conclusions reported here result from evaluation of JPO's field surveillances and engineering reports. Most surveillance and assessment reports were summarized in weekly reports that are routinely distributed to stakeholders. Information about individual surveillances or assessments is available by request from JPO's public affairs office.

How This Report is Organized

This report is structured differently from previous CMP reports. More background material has been added to aid readers in the understanding of pipeline operation issues. A difficult editorial challenge was to organize Chapter 2 into an integrated framework to present issues and conclusions from JPO's 1997-1998 monitoring of TAPS operations. Chapter 2 is organized into three subchapters: 1) pipeline control and telecommunications systems, including system improvements such as fiber optics and leak detection; 2) below ground stability systems that include problematic instances of pipeline curvature; and 3) change management. The first two subchapters draw heavily from categories found in the TAPS design basis so a consistent terminology and functional breakdown can be developed. The third subchapter introduces change management, which is a systemic deficiency, both currently and historically.

Monitoring TAPS Operations

This is JPO's first CMP report about oversight of TAPS operations. Before 1994, Federal and State oversight of TAPS focused on surface and subsurface protection, environmental issues, corrosion, oil spill contingency, and land use permitting. JPO did little monitoring on the transportation and management of oil inside the pipeline system. In response to identified deficiencies in the 1993 audits of TAPS, JPO expanded oversight to include transportation of oil inside the pipeline system. JPO planned the first evaluation of TAPS operations in late 1996, began initial field studies in 1997, and continued monitoring pipeline operations in 1998.

Chapter 2. Evaluation of TAPS Operations

- Alyeska's management of the movement of oil needs greater attention to detail, more thorough trending and evaluation of incidents, and more rigorous procedural compliance.

The hardware, software, processes, and trained staff to move oil are in place. Much of JPO's 1997 and 1998 operations monitoring addressed issues such as unscheduled shutdowns, driven by hardware or process failures in telecommunication and pipeline control.

Moving Oil Requires a Complex System of Hardware, People and Processes

The Hardware. TAPS has 800 miles of 48-inch diameter pipe, with 7 active pump stations, a tanker loading terminal and an electronic communication system. Approximately half of the pipe is below ground, with cathodic protection and below ground stability provisions. The above ground stability systems include vertical support members, anchors, bridges, and seismic and geotechnical provisions. Each pump station has a number of integrated pieces of equipment, such as turbine engines, pumps, valves, meters and relief tanks, as well as associated electrical, instrumentation and telecommunication. Each pump station has protective devices that prevent exceeding specified operating limits to ensure safe oil movement from Prudhoe to Valdez. The pipeline has 151 mainline valves and about 1,000 motorized pump station and marine terminal valves to control oil flow. The Valdez Marine Terminal contains the Operations Control Center, where TAPS is controlled through an elaborate telecommunication system. The Valdez Marine Terminal also contains storage tanks, tanker loading systems, ballast water treatment, tanker vapor recovery systems, and a large power generation facility.

Pipeline Controllers. The entire TAPS system of pumps and valves is remotely controlled from the Operations Control Center in Valdez. Pipeline controllers at the Operations Control Center watch and control all pipeline system activities to ensure crude oil flow moves within pressure, temperature, liquid level, and seismic design parameters. Pump station personnel operate and control the pumps and valves in their segment when instructed by the Operations Control Center.

Alyeska Processes and Management Controls Governing Oil Movement. Controllers follow certain procedures to operate the pipeline system under normal, abnormal and emergency conditions. Pipeline controllers use Alyeska's *Trans-Alaska Pipeline Controller Manual (DO-14)* as the primary guide for operating the pipeline. The *Procedural Manual for Operations, Maintenance and Emergencies (OM-1)* ensures compliance with Federal Department of Transportation regulations. *Alyeska's Quality Assurance Program (QA-36)* contains procedures for audits and surveillances to ensure that processes are carried out according to requirements. The *Alyeska Integrity Management System (AIMS)* is an approach designed to identify key management practices that are missing or unclear. Alyeska's oil spill contingency plan provides failure response processes.

TAPS Mechanisms That Protect the Environment, Pipeline Safety and Integrity. Leak detection, pressure alarms, seismic monitoring, valve status indicators, and automated shutdown mechanisms protect against adverse operating conditions that could potentially threaten the environment, pipeline safety and integrity. For instance, electronic systems automatically shut TAPS down when unplanned valve closures occur. Oil spill equipment is stored and ready for immediate deployment for emergency response.

Regulations and Jurisdiction of Joint Pipeline Office Agency Partners. The primary Federal regulations covering the movement of oil are contained in *49 Code of Federal Regulations 195 (Pipeline Safety)* and promulgated by the U. S. Department of Transportation, Office of Pipeline Safety. These regulations are incorporated and supplemented by additional stipulations and provisions in the Federal Agreement and Grant and Right-of-Way administered by the Bureau of Land Management and the State Lease of Right-of-Way administered by the Alaska Department of Natural Resources. Oil spill contingency is covered by each of the above agencies, along with the State of Alaska regulations administered by the Alaska Department of Environmental Conservation.

Pipeline Control and Telecommunications Systems

Unscheduled Pipeline Shutdowns

- Unscheduled pipeline shutdowns continue to occur, however, most are related to communication failures. When installation of the new fiber optics communication system and control units is complete, it is anticipated unplanned shutdowns will become less frequent.

- Alyeska needs to better trend and evaluate the shutdowns that occurred before fiber optics installation to identify causes that may not be fixed by the new installation.

Shutdowns Related to Communication Failures. Since June 1979, pipeline controllers have shut the pipeline down forty-seven times due to communications loss exceeding two minutes. Over one-third of the shutdowns occurred in 1994 and 1995. A March 5, 1997 JPO engineering report identified a continuing trend in 1994, 1995, and 1996 shutdowns related to communication difficulties. This trend was again evaluated in 1998, by conducting an assessment that addressed the same communication failures. The assessment directed Alyeska to revisit the incidents in question to assure identification of the root cause to avoid problems after the installation of the fiber optics system is complete and operational.

Communication Shutdowns: Good or Bad?

The increased rate of shutdowns due to loss of communication was driven by procedural changes to better protect the pipeline. Before 1992, the pipeline was not routinely shut down when communication was lost. This left the pipeline at risk to overpressure, should a remote gate valve close during the time communication was lost--an unlikely but possible occurrence. JPO supports the more cautious operating procedures, even with the increased rate of shutdowns.

Reducing the number of communication shutdowns is an opportunity for improvement. The number and occurrence of these shutdowns do not represent a noncompliance with Alyeska's management controls or government requirements.

Alyeska stated in their response to JPO's assessment, the root cause of the failures were hardware-related. Alyeska further stated since the aging installations were being replaced as a result of the fiber optic and remote gate valve control improvement projects, the occurrence of failures should be reduced. In the meantime, Alyeska has procedures in place requiring the pipeline to be shut down if communication is lost longer than two minutes. JPO has no evidence to dispute Alyeska's conclusion, but will monitor future shutdowns for causes that would *not* be addressed by the fiber optic system and the new control units.

Shutdowns Related to Mainline Units. JPO conducted investigations of two separate incidents at Pump Station 4 in May 1998. A common root cause was not identified for the two incidents, however, investigation revealed pipeline safety systems had responded as required. The Pump Station 4 relief tank is normally used to divert oil and relieve pressure. However, it had been removed from service for maintenance when the incidents occurred. Without the relief tank in service, mainline overpressure protection was accomplished by a station shutdown, using automatic controls, rather than the pump station pressure relief system. Relief Tank 140 has been returned to service, so this type of inadvertent pipeline shutdown should decrease.

Unplanned Shutdown Incidents

On May 24, 1998, a shutdown incident occurred at Pump Station 4, involving a pump, or mainline unit (MLU) swap. Pump Station 4 has three MLU's, two on-line and one in stand-by, that are periodically swapped as part of the regular maintenance strategy (*see Appendix I photos*). When a MLU swap is executed properly, the standby MLU is brought to idle and subsequently loaded. The MLU selected for stand-by is then idled and shut down. During this particular unit swap, the OCC Controller mistakenly shut down MLU #2 before idling, which caused a pressure device to shut down Pump Station 4.

A second incident occurred at Pump Station 4, on May 27, 1998, as a result of a mechanical alarm that shut down MLU #2. The cause of the alarm was due to the MLU #2 lube oil pump, which was removed from service and inspected for damage and wear. No apparent problem with the lube oil pump was identified, although it was noted several preventive maintenance activities for the lube oil pump were back logged.

Why Did These Events Result in a TAPS Shutdown?
When a pump suddenly stops, suction pressure increases due to reduced oil flow rate, which then increases the static head pressure. If the suction pressure exceeds the already programmed pressure settings, the pump station is automatically idled.

JPO recommended that Alyeska trend pipeline shutdowns caused by mainline units, to determine if a mainline unit swap procedure for normal pipeline operations is necessary. JPO also conducted a surveillance of training issues related to the mainline unit swap procedure, without finding any significant deficiencies. Oversight will continue for these incidents as they occur.

Trend and Causal Factor Analysis. Alyeska has committed to use trend and causal factor analysis to meet the requirements of CFR 195.402 (d) (1) Responding to, investigating, and correcting the cause of: (I) Unintended closure of valves or shutdowns; (ii) Increase or decrease in pressure or flow rate outside normal operating limits; (iii) Loss of communications; (iv) Operation of any safety device; (v) Any other malfunction of a component, deviation from normal operation, or personnel error which could cause a hazard to persons or property.

Trend and Causal Factor Analyses

Trend and causal factor analyses are tools used to determine potential trends, implications adverse to quality, and process improvement areas. The procedures and requirements governing the use of these tools are found in Alyeska's safety manual and quality program Principal Implementing Procedures.

Trend Analysis
A trend analysis is used to identify patterns of occurrence related to people, processes and hardware. Alyeska's objective of trend analysis is to discover trends related to quality and to use them as a tool in the decision making process in continuous improvements, quality, operations, maintenance, or other business activities. Trending should be done on a continuous basis. The data are weighed to reflect significance, and are compared with previous trend results. Trends are reported quarterly. The *Trend Analysis Summary Report* is sent to the appropriate managers tasked with coordinating the determination, if an adverse trend requires the issuance of a corrective action report or root cause analysis.

Causal Factor Analysis
A causal factor analysis identifies the cause of a problem. This analysis examines personnel, hardware, procedures, and environmental effects. It involves a detailed, systematic review of cause and effect conditions to determine the root cause and propose actions to rectify the condition and prevent recurrence.

What's Involved in the Process?
Sources of data for analysis include nonconformance reports, quality and environmental audit findings, surveillances, incident reports and other appropriate documents.

Operations incident investigation, evaluation and trending has been an Alyeska weakness, documented by JPO's 1997 surveillance. To Alyeska's credit, their 1998 quality audit also identified these weaknesses. In the same report, Alyeska committed to make corrective actions. A May 28, 1998, JPO assessment report contained a finding that causal factor analysis was not

being performed in accordance with Alyeska's Quality Manual and inconsistencies were noted in the format used to investigate equipment failures. The assessment recommended a review of incidents to assess the adequacy of the causal factor analysis process.

Alyeska's handling of an August 5, 1998, overpressure incident (discussed on p.14) used the appropriate root cause tools. Further, they have tightened the management over the pipeline control function. Alyeska's future performance in trending and evaluating shutdowns and other incidents will determine whether deficiencies in the use of causal factor analysis are corrected.

Planned Re-starting of the Pipeline

- Alyeska's performance in re-starting the pipeline system improved during the last shutdown covered in this reporting period. However, Alyeska needs to better plan re-starts to: 1) ensure attention to detail on procedure revision, 2) complete functional testing of new and repaired hardware, 3) document changes in operating status, and 4) develop contingencies for activities conducted during shutdowns to avoid recurrence of problems from previous re-starts.

During 1997 and 1998, TAPS had several planned maintenance shutdowns. Frequent problems occurred during re-start activities both at the pump stations and the Operations Control Center in Valdez. Procedural lapses were found that revealed pipeline re-starts had not received needed management or attention to detail. Procedures could have improved, functional checks should have been completed, and contingencies better anticipated. The experience and skill of controllers and hydraulic engineers was evident, but better planning could have made re-starts less eventful.

The September 1998 re-start during a valve repair and replacement project showed a significant improvement and better attention to procedures and detail. The procedural changes clearly reflected lessons learned from earlier re-starts. While these improvements were commendable, strengthening Alyeska's change management processes is necessary to ensure that contingency events associated with testing new products such as Gel Block or system modifications are anticipated. Alyeska needs to aggressively manage this, given the natural tendency for controllers to work from experience, rather than follow detailed procedures.

The following is a summary of incidents that occurred in the re-starting of the pipeline after being shut down:

1. During the August 1, 1997 re-start, Alyeska allowed the pipeline to be overpressured. While the overpressure did not threaten pipeline integrity or damage the pipe, this overpressuring was neither trivial nor unpreventable. It was a violation of U.S. Department of Transportation, Office of Pipeline Safety regulations. Two of the findings from JPO assessment, *1997 TAPS Shutdown and Re-start*, address Alyeska Quality Program requirements covering procedure modification and waivers. Conformance with the Alyeska Quality Program requirements may have prevented this incident.

2. Before the August 8, 1997 re-start of the pipeline, the pressure relief system at the Valdez Marine Terminal malfunctioned. The incident, which was manageable, is not the issue of concern. Instead, functional testing requirements of Alyeska's Quality Program should have exposed this problem before re-starting the pipeline.

3. In August 1997, during and after testing of Remote Gate Valve 60, Alyeska tested a valve sealant, called Gel Block. Approximately 4,000 gallons of the Gel Block remained in the pipeline after the test, clogging screens and causing the pumps to vibrate at Pump Station 7. This resulted in an upset condition. The potential for this upset condition should have been anticipated and contingencies planned.

4. The June 20, 1998 shutdown was scheduled to test several remote gate and check valves to gather data for Alyeska's valve maintenance program. The re-start was well managed except for one unexpected event. When testing was complete, Remote Gate Valves 58, 59, and 60 failed to function when commanded from the Operations Control Center in Valdez, and had to be opened locally. The failure to open was due to a block line sequence logic that did not complete its sequence. The cause of the incomplete sequence was due to a valve at Pump Station 5, that was locked open for maintenance when the block line sequence was initiated. The sequence logic and equipment had performed as designed.

Pipeline Pressure Control

- Alyeska did not follow their quality control practices for calibrating and maintaining pressure control devices and documenting the results. However, they have implemented corrective action plans to fix this problem, including a plan to increase surveillance of tracking and controlling pressure relief system devices to prevent these problems from recurring.

TAPS has safety mechanisms in place to maintain pressure within safe operating limits and prevent overpressure along the pipeline. Alyeska's Quality Assurance Program ensures proper procedures are in place to maintain the integrity of the pipeline. Pipeline pressure is controlled and maintained according to Alyeska's quality control procedures. Each operating pump station along TAPS has pressure control devices to prevent pressure from exceeding safe operating limits.

Pipeline controllers follow written procedures for maintaining pressure control. The procedures cover both normal and abnormal operation. Controllers must use specific settings when adjusting devices to control pressure. These settings are referred to as pressure control set points. Set points are critical because they control relief valves that prevent exceeding maximum oil pressures allowed by U.S. Department of Transportation regulations. For example, if oil pressures exceed the set point value, relief valves automatically open to reduce the pressure. Alyeska's hydraulic engineers calculate set point values for each pump station, based on flow rate and pipeline configuration. Set point values are also calculated for upset conditions and are specified by Alyeska's operating manuals. The Operations Control Center (OCC) in Valdez has the responsibility for the settings and maintenance of the field pressure control set points along TAPS. OCC controllers input the set point values in the automated pressure control system for the entire pipeline.

JPO conducted a surveillance to 1) verify that the OCC controllers were operating the pipeline in accordance with the pressure control set points developed by Alyeska's hydraulic engineers, and 2) verify that the equipment used to support the operation of the pressure relief system was calibrated in accordance with Alyeska's Quality Assurance Program. Controllers used the set points specified by hydraulic engineers, but Alyeska had problems following their quality

control practices for calibrating and maintaining the pump station pressure control devices. Set points were not consistently documented and labeled on some of the devices used to control pipeline pressure, as required by Alyeska's *Quality Program Manual*. JPO could not verify calibration set points and frequency of calibration due to: 1) missing labels on the pressure control devices, and 2) missing calibration documentation. Alyeska requires calibration labels to be attached to all pressure control equipment, since they contain essential set point value information. Without them, pipeline controllers cannot be assured the settings are maintained within the safe operating parameter (*see Appendix II photos*).

Alyeska's quality control procedures contain a two-step level for safety: 1) pressure control devices are calibrated using a specific set of procedures, and 2) the set point values of each control device are documented in a written record. Labels are attached to each device with the specific value against which it was calibrated. The intent of these safety precautions is to ensure all pressure control devices on TAPS are accurately maintained according to recommended industry practices, and to ensure regulatory compliance.

Alyeska concurred with the finding and took action to re-calibrate pressure control devices and revise their tracking and documentation procedures. They plan to increase their surveillance to prevent recurrence of this problem. JPO accepted Alyeska's response to this issue, and will continue to monitor Alyeska's compliance with their quality program and pipeline operating procedures concerning pipeline pressure control.

Pipeline Overpressure of August 5, 1998

- JPO continues to monitor Alyeska's ongoing investigation of an overpressure event that occurred in August 1998. A preliminary Alyeska engineering review concluded that pipeline damage was unlikely. JPO recently obtained the pipeline pig data and is currently evaluating it to verify Alyeska's conclusion.

- Alyeska identified lessons learned and completed some corrective actions, with other corrective actions remaining to be completed. An oversight priority is to ensure Alyeska implements preventive measures to minimize future occurrences.

On August 5, 1998, a significant overpressure of the Trans-Alaska Pipeline System occurred. Hydraulic pressure exceeded 110% maximum allowable operating pressure (MAOP) in the 32-mile segment between Pump Stations 9 and 10. Alyeska completed a hydraulic analysis indicating the pressure had peaked at 130% MAOP near Pipeline Milepost 568, south of Delta Junction, Alaska. The cause of the event was thought to be a pipeline controller error at the Operations Control Center in Valdez. Alyeska began an immediate, formal investigation to determine the root cause.

JPO's records review revealed two more overpressure incidents had occurred later the same day, while Alyeska was responding to the incident. JPO became concerned about the two additional overpressures because Alyeska had not identified them. JPO could not find specific procedures for the response and investigation of the overpressure incidents. Analysis of the data led JPO to question how Alyeska initially responded to this incident. JPO is also concerned about Alyeska's slow response in implementing remaining changes to prevent future overpressure incidents from recurring, and will continue to monitor this issue.

JPO found a lack of procedures for the response and investigation of pipeline overpressure events, and discussed with Alyeska the OCC controller's ability to manage overpressure events; along with recommended procedural improvements for responding to and investigating events. A letter was sent to Alyeska, requesting: 1) the status of potential system changes that Alyeska committed to make, 2) procedures for investigating and responding to pipeline overpressures, and 3) a detailed analysis of all overpressure incidents that occurred on August 5, 1998.

After reviewing the records and evaluating the situation, JPO concluded improvements in the real time hydraulic display controllers use to determine the oil pressure gradient are necessary. The gradient does not accurately represent pipeline pressures during surge events. Surge events generally occur during upset conditions, when oil flow stops abruptly. When valves unexpectedly close, the front of the oil flow is suddenly stopped as it slams against the closed valve, creating a surge wave that abruptly moves in the opposite direction.

Pipeline Overpressure
U.S. Department of Transportation, Office of Pipeline Safety regulations specify a pipeline controller shall not exceed the maximum allowable operating pressure of 100% for the pipeline, except in abnormal conditions. Excess oil pressure is a concern due to the potential for leaks or ruptures in the pipeline. Normal operating pressures vary according to the topography the pipeline traverses. Under abnormal conditions, the regulations allow pressure up to 110%.

Pipeline Integrity
Alyeska visually inspected the affected pipe segment and found no indication of excessive stress conditions of the pipe or valve. Alyeska also tested for presence of hydrocarbons at Remote Gate Valve 88 and Control Valves 89 and 90. All test results were negative. In October 1998, Alyeska sent the deformation pig through the pipeline from Pump Station 4 to Valdez to confirm pipeline integrity. JPO is currently evaluating the pig data to verify Alyeska's conclusion there were no excessive stress conditions of the pipe and valve.

As a result of the August 5, 1998 overpressure event, Alyeska planned some system changes for 1999. The changes will make it possible to determine the status of the valves downstream of the pump stations which have been ramped down, or removed from operation. Alyeska recently completed a causal factor analysis which not only addresses this event, but other pipeline controller errors. It identifies many of the programmatic deficiencies cited in this CMP report, including the principles of change management, which Alyeska has not effectively employed. It is a positive step and consistent with the Quality Assurance Program. Nevertheless, Alyeska needs to complete the corrective action and respond to issues JPO has identified.

Pipeline Hydraulic Model

The procedures for the use and maintenance of the pipeline hydraulic model need clarification in Alyeska's manuals. While no major problems were found, much confusion can be eliminated if procedures for using the hydraulic model were clearly stated in the appropriate manuals.

The hydraulics and internal pressures of the pipeline are continuously displayed, monitored, and calculated on the OCC pipeline controller's computer screen. The pipeline hydraulics model is a tool controllers use to determine pipeline pressures during steady state operation. (See *Oil Movements Gradient Chart* in appendix). JPO incorporated the hydraulic model in the 1998 work plan because: 1) it provided an opportunity to examine three priority one audit action items which had been previously closed, 2) the *Oil Movements Gradient Drawing* appeared to be out of date, and 3) the hydraulic model is a key tool for the safe operation of TAPS.

JPO's surveillance report contained two findings: 1) The *Oil Movements Gradient Drawing* had not been recently updated, and 2) milepost calculations in Alyeska's Engineering Data Management system were inaccurate. After evaluating Alyeska's response to these findings and investigating the matter further, JPO concluded that neither issue presented an imminent threat to system integrity or pipeline safety. Alyeska has agreed to clarify their manual procedures and update the Engineering Data Management system to remove inconsistencies.

The Oil Movements Gradient

The *Oil Movements Gradient Drawing* is an on-line chart that tracks oil movement linewide, and is displayed on the Operations Control Center pipeline controller's console (See *Oil Movements Gradient Drawing* in appendix). Alyeska Manual OM-1, the *Procedural Manual for Operations, Maintenance and Emergencies*, specify the maximum allowable operating pressures defined in the oil movements gradient. Neither the drawing nor the on-line oil movement gradient defines these terms. The definition of maximum allowable operating pressure resides in Alyeska's engineering data management system, the corrosion data management system, pipe purchase and installation records, and hydro-test records. The drawing 1) does not directly tie to the pipeline hydraulic models, and 2) is only used for planning, training, and rough approximations of pipeline operations. It isn't used to define maximum allowable operating pressures, operate the pipeline, or determine the set points referenced in the *Department Operating Procedure* manual.

The survey data used in the *hydraulic models* is a compilation of data from all of these sources for only those points on the pipeline of hydraulic significance--often referred to as pinch points. It is not a compilation of maximum allowable operating pressure for every point or joint of pipe on the pipeline system. This is acceptable because most areas of pipe cannot be operated near their rated limits due to the need to stay below these pinch points. These are located in areas where high pressures must be maintained to move oil. In summary, the manual reference to the oil movement gradient in OM-1 is not completely accurate and Alyeska plans to delete it.

Pipeline milepost calculation problems in the Engineering Data Management (EDM) system began in November 1996, resulting in inconsistent pipeline milepost numbers in the report. Sometimes the mileposts agreed with the hydraulic survey database, but often they were offset as much as 0.034 miles. On April 3, 1998, Alyeska's pipeline hydraulics group decided to resolve the problem. EDM is now calculating correct pipeline milepost data, based on additional survey equations added by Alyeska's system integrity team.

Alyeska committed to revise OM-1 and improve the documentation of annual reviews and update the milepost numbers as a training exercise for new hydraulic engineers. JPO verified that Alyeska complied with promises made in 1995 to close audit findings regarding the hydraulic models. The Joint Pipeline Office concurred with Alyeska's response that the *Oil Movements Gradient Drawing* has no direct ties to the pipeline hydraulic model and the survey data are now being calculated correctly. However, because of the recent overpressure event, it may be necessary to implement improvements in the real time hydraulic display that controllers use to determine the oil pressure gradient. JPO will monitor Alyeska's activities to verify that models are updated, manuals and documents are revised, and controlled copies are distributed as required.

Controller Training

- Employees controlling oil flow have received considerable training, however, Alyeska needs to complete its qualification and development program (QDP) initiative and comply with the self-audit and team qualification plan aspects of the program for all system controllers and operators.

- Alyeska's evaluation of recent controller errors revealed that some controllers lack full knowledge of the pipeline control systems and the training program does not effectively assess controller performance under abnormal operating conditions.

The employees controlling the pipeline have received considerable training. The largest substantive weakness in controller training involves inadequate and poorly implemented change management processes. Despite training, OCC controllers lack full knowledge of the pipeline control system including the systems that automatically shut down the pipeline if a problem occurs. As the pipeline system changes configuration through ramp down, testing or repair, controllers should understand the ramifications of these changes according to what information is on the display screens. Controllers should also understand how these changes affect the automatic functions driven by the computer. Two recent events illustrate this problem. Both involve controllers who were experienced and trained.

- The June 20, 1998 re-start had a delay in opening Remote Gate Valves 59 and 60. JPO conducted a follow-up surveillance at Pump Station 5 to determine if the cause of the delay was training related, and concluded it was not. In fact, one of the trainers was at the controls at the time. The reason why the control logic would not allow the controllers to open the valves was related to activities conducted during the shutdown, the implications of which weren't initially recognized even by a controller trainer.

- During the August 5th overpressure the controller made wrong decisions in a situation complicated by valve control modifications and control screens that didn't fully reflect ramp down reconfiguration. As mentioned earlier, Alyeska committed to additional training, recertification and modification of some of the screen displays. Better anticipation of the complications in TAPS operations due to both ramp down and day-specific testing or repair is needed.

Alyeska's recent causal factor analysis of OCC pipeline controller errors recognized this problem and recommended corrective action. Alyeska's new pipeline control simulator should be a useful tool for training and skill development, and can be used to address change management. JPO encourages Alyeska to make full use of its new pipeline control simulator and to critically evaluate its effectiveness.

The Qualification and Development Program (QDP) for pipeline controllers and operators is underway. However, it will not be considered fully implemented until: 1) qualification instruments are validated and entered in Alyeska's training administration system; 2) all team members are qualified to use designated core qualification instruments, and 3) all program components are complete and documented, including team qualification and business plans.

Why Was The QDP Initiated?
The Qualification and Development program (QDP), initiated during 1994 and 1995, is a result of the 1992 Owners Safety Audit, the BLM Audit, and the TAPS assessment to address technician capabilities. A one year site-specific pilot program was developed and implemented in the Operations Control Center in late 1995, and a site-specific program for the pipeline control rooms was initiated in August 1996. Implementation of these two programs closed ten audit action items. The primary audit action item, full QDP implementation, remains open and is scheduled for closure later this year.

The QDP's Purpose
The purpose of the QDP is to ensure no technician or controller will be expected or allowed to perform core tasks without passing a qualification assessment on that task. Newly hired technicians are level one of a six-level progression system. After successfully completing basic training, they move to level two and enter the regular technician work force. A level two technician has one year to achieve qualification to level three. Further progress is at the technician's direction and is achieved by qualifying on additional qualification instruments. However, technicians may be required to become qualified on higher level tasks by their team leader, based on business needs. Improving the QDP program is an ongoing task and JPO will continue to track program progress.

JPO's 1998 work plan included an assessment of Alyeska's progress in completing the QDP. The QDP assessment focused on the qualifications and training of those employees directly controlling the movement of oil linewide. The assessment identified findings related to the development of team qualification plans and failure to conduct an internal audit as required by the *Qualification and Development Program Manual*. All OCC controllers in Valdez are now required to complete a pipeline training class, using the new simulator.

The primary audit action item of full QDP implementation remains open, and is scheduled for closure in 1999. To close the main audit item, the above findings must be corrected along TAPS and at the Valdez Marine Terminal. When pump station personnel complete the closure criteria, Alyeska and JPO will verify it. Alyeska plans to close this audit item by November 1999.

TAPS Leak Detection System

- New leak detection technology has the potential to improve Alyeska's ability to promptly detect and respond to small, slow oil leaks from the pipeline system. Alyeska is reviewing the latest technology for leak detection, which JPO strongly encourages. Alyeska's new transient volume balance system is an improvement, but needs a comprehensive performance evaluation now that start up problems are resolved. JPO incorporated this request as a condition of approval of Alyeska's oil spill contingency plan. Improving leak detection will remain a top priority for oversight.

Alyeska commissioned the new Transient Volume Balance system of leak detection at the beginning of 1998. JPO reviewed the transient volume balance system data, focusing on the testing of false alarms. The results were included in JPO's evaluation of the TAPS mainline oil spill contingency plan and led to a condition for oil spill plan approval, requiring a formal review of system performance and reliability.

The TAPS Leak Detection System

The TAPS leak detection system uses oil flow and pressure measurements to detect oil leaks in the pipeline system. TAPS has three systems that detect leaks:

Transient Volume Balance System (TVB)
This is a new leak detection system recently put into operation at the Operations Control Center in Valdez. The Transient Volume Balance system can detect whether a leak may be occurring and can identify the leak location by segment, especially with larger leaks. This system is based on transient flow modeling of the pipeline with data updated every 10 seconds. The

volume balance is called transient because it takes into account a non-steady state flow. The TVB models compare the modeled flow to the flow measured by the leading edge flow meters.

Leading Edge Flow Meters (LEFMs)
The metering system has leading edge flow meters which estimate the oil flow rate from the difference in time it takes a sound wave to travel in the direction of oil flow versus against the direction of flow. Data from the flow meters are fed to the *Supervisory Control And Data Acquisition System (SCADA)* for transmission to the Operations Control Center in Valdez. These data are used for leak calculations and continuous monitoring of pipeline status by the pipeline controller. These instruments were recently upgraded to close an audit action item.

Line Volume Balance System (LVB)
The Line Volume Balance System was the former primary system for detecting small oil leaks. The Line Volume Balance portion of the leak detection system senses leaks by checking the oil volume in the pipeline every 30 minutes. The system compares the volume entering the line with the volume leaving the line, adjusting for temperature, pressure, tank-level changes, and slack line conditions**.**

Deviation Alarms
The deviation alarm system detects large leaks, greater than 1% of oil flow. There are three types of deviation alarms: 1) *pressure alarms* occur when the oil pressure changes by more than 15 pounds per square inch, 2) *flow alarm*s are activated if the amount of oil entering or leaving a pump station varies too much between check times, and 3) *flow deviation alarms* are activated when the difference in the amount of oil flow between the upstream and downstream pump stations changes to greater than 700 barrels per hour flow. This calculation is performed on each pipeline section several times a minute.

False alarms analysis provides a measure of the performance of the transient volume balance system instrumentation and its ability to model real world pipeline conditions. The sensitivity of the leak detection system is always balanced against a manageable rate of false alarms. An alarm that cannot be attributed to a measurement problem or pipeline event will require Alyeska to conduct a field surveillance.

JPO reviewed leak alarm records from January through September 1998, to evaluate the transient volume balance system false alarms recorded by OCC controllers in Valdez. JPO concluded the analyses of the false alarms for the transient volume balance system indicated 1998 performance was hindered by start up problems with the new, upgraded leading edge flow meters (LEFM). Performance was also hindered by the temporary use of a strap-on LEFM meter in Valdez during the operation of the temporary backpressure system.

JPO also plotted false alarms versus location, and found they are not evenly distributed. When known start up problems and those associated with the Valdez back pressure system are discounted, the distribution clearly singles out the Pump Station 5 and 6 segments due to the temperature of the oil. Paraffin wax deposition is temperature dependent and this segment is where the oil cools and paraffin is deposited from the crude oil. JPO speculates the scraper pigs push the paraffin wax into the ports housing the LEFM sensors. Alyeska should review this situation to see if a maintenance schedule or equipment modification can improve LEFM and transient volume balance system performance. In response to JPO's review, the Alaska Department of Environmental Conservation recommended that Alyeska produce a report on the transient volume balance performance. The recommendation is currently in the *Trans-Alaska Pipeline System Pipeline Oil Discharge Prevention and Contingency Plan Findings Document and Response to Comments* under Issue #14, *Leak Detection for Crude Oil Pipelines.* The report should contain the following elements:

1. An analysis of the number of false alarms per month categorized into causal groups.

2. A performance summary characterizing the quality of the data input into the TVB system

including a measure of the loss of availability of the LEFM's and other input data such as pressure and temperature.

3. A summary of the median detection threshold and threshold range of each pipeline segment for the hour, 4 hour, and 8 hour averaging periods.

JPO encourages the use of the newest, most advanced technology available for leak detection. Some improvements are achievable in the transient volume balance system, but dramatic improvements await new technology and a different approach. In 1997, JPO funded the State of Alaska's Aerospace Corporation to work with Alyeska to find new approaches to leak detection. Alyeska published a formal solicitation, which yielded twenty-five proposals. Evaluation of these proposals did not identify an immediate solution, but did yield several promising leads for new technologies. To Alyeska's credit, they are currently working with NASA's Jet Propulsion Lab to explore new sensors and technology. The explored approaches are not off the shelf and would substantially advance the best available technology paradigm for pipelines. JPO is strongly encouraging Alyeska in this pursuit.

As a final point, much of JPO's monitoring is to push Alyeska to attend to details and procedures. Small, slow leaks are undetectable by current leak detection systems, however new technology presents an opportunity to improve Alyeska's ability to promptly detect and respond to small, slow leaks. Improving leak detection will remain one of JPO's top priorities in future work planning.

Questions & Answers About Leak Detection

What is the most critical factor that determines how fast a leak can be found? The larger the leak, the faster it can be found. Small, slow leaks cannot be detected. The speed of detecting a leak is dependent on the size of the leak, measured in terms of barrels per day (BPD). The size of the spill before detection varies and is determined by multiplying the leak rate by the time to detection, which equals the leak volume in barrels (BBL).

What are other factors that affect performance of a leak detection system? The steadiness of the flow, the packing of the line and the repeatability and accuracy of the flow measurements. (A pipe full of oil is referred to as packed, and a partially filled pipe is called a slack line).

Is the new transient volume balance system a significant improvement? Yes. It is the first leak detection system used on TAPS that detects leaks within a pipeline segment (between two pump stations) and takes into account dynamic flow conditions and effects of drag reduction agents. It is state-of-the art at the current time.

Can the transient volume balance system be improved to detect small, slow leaks? No. Detecting small, slow leaks requires a different approach to technology.

What were the original design basis requirements for small leak detection? The design basis estimated that the minimum detectable leak volume at a flow rate of 2,000,000 barrels per day would be 560 barrels. At 600,000 barrels per day, it would be 750 barrels using the line volume balance. The design basis curve shows that leak detection would only be possible for leak rates above 3,000 barrels per day.

Do the transient volume balance system detection limits meet the original design basis leak volume limits? Only under optimal conditions does the leak detection system approach the original design basis expectations. In one simulated leak test with tight line, the transient volume balance system found a 4,000 barrel per day leak in 3.7 hours, for a volume of 617 barrels. Slack line testing gave considerably worse results, taking 10.9 hours to detect a 9,696 barrel per day leak with a volume of 4,404 barrels.

What is JPO's focus for leak detection oversight?
To encourage new technology to detect small, slow leaks and to review transient volume balance system experience for reliability and cause of false alarms.

Fiber Optics Cable Project

- Alyeska is replacing their current backbone communication system with a new fiber optics system and new valve control units. The purpose of these projects is to improve the reliability of the remote gate valve system on TAPS and decrease unplanned shutdowns, minimize incidents of communication lapses, and enhance pipeline system safety. JPO will verify reliability and safety of the system once it becomes operational.

Fiber Optics in Alaska
More than 6,000 miles of fiber optic cable is being laid across the state of Alaska to better connect the state with the Lower 48 and the rest of the world. Cable is being laid from Prudhoe Bay, through Fairbanks to Valdez. When the system is completed, it should increase the state's communication capacity by 40 times what it is currently.

The fiber optics cable system consists of a communications network from Pump Station 1 to the Valdez Marine Terminal, including service to the Fairbanks Network Operations Center, major river crossings, and airports. Fiber optic lines use pulses of light to send vast amounts of information great distances at extremely fast speeds. The system will transport all communication traffic now transported by the current backbone communications system. The system is being constructed on a separate right-of-way from TAPS, but overlaps the TAPS right-of-way for a large part of the route.

Fiber optics should increase the speed of communications and improve reliability. Equally important is the ongoing project to replace the aging and obsolete remote gate valve and master terminal units with updated ones. The fiber optics should improve the informative alarms and provide better information to pipeline controllers (*see photos in Appendices IV and V*).

The master terminal replacement project encountered numerous employee concerns, and the project was temporarily stopped to assess these concerns. Plans are being made to institute better managerial cost and quality controls. The employee concerns focused on other electrical, maintenance and testing duties also being performed by the project team. The formal stop work order was prudent and an appropriate use of Alyeska's quality program and supports the implementation of necessary controls. JPO has encouraged Alyeska to address the concerns and move forward with the project, which is one of two remaining priority one (P1) open audit action items.

The system testing, documentation and change management involved in the use of the fiber optics and Triconex systems are important. Oversight of this effort will be a priority in JPO's 1999 work plan.

JPO received Alyeska's application for a notice to proceed (under Stipulation 1.7) to perform the switch from the old communications system to the fiber optics cable project. It was approved in part, in accordance with the stipulation requirement that permittees maintain communication systems. The approved aspects do not apply to the control of valves or pumps, but to other communication which will be useful for system testing. JPO requested the following additional information prior to approval for remaining aspects of the notice to proceed:

- Documentation for the seismic certification of the fiber optics equipment (inclusive of the

racks, their anchorage, and cable support), and allowing for differential seismic movements at Pump Station 12, the Operations Control Center in Valdez, and the signal booster site at Remote Gate Valve 97.

- Documentation of the seismic certification for the Network Operation and Control Centers located at Prudhoe Bay, Fairbanks, and Valdez.

- Documentation to support the claim that the fiber optics system can accommodate the increased light attenuation between the fiber optics cable specification temperature minimum of -40 F and the design basis requirement of -60 F.

- The test procedure for judging if critical communications can continue if the fiber optics cable is completely severed exiting Pump Station 4.

TAPS Cold Re-start

- A TAPS cold re-start study must first be completed before developing a new plan that includes procedures for re-starting the pipeline under extreme cold conditions after an extended shutdown. Study results will help Alyeska obtain objective information about system performance in the event of an extended shutdown.

JPO has been concerned about problems re-starting the pipeline after an extended shutdown during extremely cold weather. The concern grew after the ramp down of four pump stations, which caused procedures in the old re-start plan to be outdated. Four less pumps to move cooled oil meant less horsepower to start a pipeline after a long shutdown.

Alyeska has committed to develop a new cold re-start procedure. However, the project has been delayed to complete a study to determine the amount of pressure it takes to move cooled, thickened, and possibly gelled oil. Even though oil may turn to a gelled state, pipeline pressure must still remain within the maximum allowable operating pressure. Completion of the study (referred to as the cold rheology study) is planned for the second quarter of 1999. The study objective is to determine how oil properties change as the oil cools and how the oil is affected by temperature changes. Once the results of the rheology study are obtained, a thermal and hydraulic analysis should be completed to determine the amount of pressure it takes to move the cooled oil.

In the meantime, Alyeska is developing computer software to simulate pipeline pressure under a re-start scenario. JPO encourages Alyeska to complete the rheology study and the subsequent thermal and hydraulic analysis, to obtain detailed information about system performance during start-up, after an extended shutdown. Once the rheology study and the hydraulic analysis is completed, a new cold re-start plan with updated re-start procedures should be initiated.

Progress on Year 2000 (Y2K) Compliance

- JPO finds Alyeska's Y2K effort to be well planned and organized. Alyeska's late start may increase the cost of the Y2K program, but there are no concerns about its

effectiveness.

JPO has been monitoring Alyeska's progress of compliance with the year 2000 computer problem, and found there is active work on this issue. The first phase was to determine what changes would be necessary. Alyeska began their Y2K program two years later than most other oil companies. JPO has maintained regular contact with Alyeska's Y2K project lead to monitor compliance efforts, and to stay informed of any circumstances which could hinder Alyeska's ability to successfully meet Y2K requirements. The program appears to be well planned and organized. The impact of starting the Y2K compliance program at a later time may raise the cost of the overall Y2K effort, but JPO sees no concerns about program effectiveness.

Below Ground Stability Systems

Several issues addressed by the operations CMP team involve below ground stability systems. Above ground stability issues covered in 1997 and 1998 were handled by the maintenance CMP team and will be addressed in the upcoming *CMP Maintenance Report*.

Mainline Refrigeration Site No. 2

- JPO does not believe the pipe curvature at Mainline Refrigeration Site No. 2, near the Gulkana River, is a pipeline integrity concern provided 1) the curvature remains constant or decreases, 2) oil temperature does not significantly increase, and 3) pipe wall wrinkling does not occur. All are aspects which can be monitored. Alyeska is currently assembling performance based criteria to evaluate areas of high curvature which should result in a site-specific design basis waiver scheduled for completion in early 1999.

What is MLR-2 and why is it a concern?	Why is MLR-2 a good case study?
Main Line Refrigeration Site No. 2 (referred to as MLR-2) is a 2-mile long buried section of pipeline near the Gulkana River north of Glennallen, Alaska. This is a segment of pipeline that resides in ice-rich, thaw susceptible soils. This area of the pipeline system requires mechanical refrigeration to ensure the soils remain frozen to prevent pipe settlement. Because of the lack of adequate refrigeration, soils below the pipe at MLR-2 thawed. Refreezing of the soils could cause upward movement of the pipe.	**When this issue arose, it appeared that pipeline integrity was in question. This situation occurred because Alyeska failed to closely monitor the installation and maintenance of the refrigeration units. The pipeline insulation was wet, contrary to the TAPS design basis, and the curvature also exceeded the design basis. This is not an uncommon problem. Poor maintenance or procedural compliance usually leads to situations where the pipeline deviates from its design basis specification and becomes indeterminate, i.e. not demonstrably within design parameters.**
Localized thawing of the soils resulted in pipeline operation and maintenance problems, such as thaw settlement and curvature of the pipeline. Pipeline curvature is a concern because it stresses the pipe, which potentially could result in wrinkling. If allowed to continue, this could cause pipe buckling and subsequent oil leakage. Alyeska installed temporary refrigeration equipment, which is currently in operation, and is in the process of replacing it.	**The approach to evaluate MLR-2 was similar to how JPO studies other issues: 1) Determine whether the pipeline is safe. This step frequently requires a second opinion from a contracted consultant, usually a Department of Energy National Laboratory. 2) Identify process issues and resolve them. 3) Require the system to comply with the design basis or adjudicate engineering-supported waivers or modifications. 4) Verify that corrective and preventive actions have been completed.**

In 1997, Alyeska assessed the integrity implications of the pipeline curvature at MLR-2. JPO reviewed the resulting report and TAPS monitoring rod data (monitoring rods indicate settlement of the pipe after burial). The data indicated the curvature of the pipeline at MLR-2 under current

operating conditions does not require re-leveling of the pipeline in that area.

JPO requested Alyeska to:

- Continue monitoring the position of the pipe on a monthly basis.
- Use pig data to verify no wrinkles have formed in the pipe.
- Develop a maximum allowable curvature criteria for remote gate valves.
- Request a design basis waiver for the curvature at MLR-2.
- Request a design basis waiver to address the fact that the design basis maximum differential temperature is no longer allowable at MLR-2.
- Obtain JPO approval for the design basis waivers and ensure that all other existing conditions conform to the design basis requirements.

JPO continues to review monitoring rod data and operating conditions in order to protect the integrity of the pipe at MLR-2. Monitoring data will provide an alert of pipe distress or distortion of Remote Gate Valve 98A if excessive rebound of the pipe occurs.

Migrating caribou are the reason for the MLRs.

The Nelchina caribou herd migrates annually across the Gulkana River and the Richardson Highway between Sourdough and Paxson. At the time of TAPS construction, State and Federal fish and wildlife experts recommended a below ground pipe mode in two areas (MLR-1 and MLR-2) in the seven miles between the Gulkana River and Hogan Hill. Resource managers feared that an above ground pipeline might function as a fence, affecting migrating wildlife.

The effect of above ground pipe on Nelchina caribou movements has been studied since construction. Indications are they may have avoided elevated pipe to some extent immediately after construction of the pipeline, when TAPS was a new feature on the landscape.

During October 1998, JPO surveyed caribou migrations in the MLR areas as well as at other points in the 26-mile wide corridor used by migrating animals this year. Conditions for a survey were optimal (it was the optimal conditions which prompted JPO to add this survey to its work plan). The migration of over thirty-thousand caribou occurred between October 23 and 25th. During this period, new snowfall was minimal, allowing tracks to show clearly in the snow already on the ground. Snow cover ranged from 4 inches near the Gulkana River pipeline crossing, to about 12 inches in the Meiers Lake vicinity. Tracks left by this large caribou migration showed that the animals crossed under the above ground pipeline as well as over buried pipeline segments, with no apparent concern or preference. No evidence of caribou avoidance or of lateral movement of caribou along the above ground segments was found.

Salcha River Pipeline Curvature Analysis

- Review of pig data confirms that no intervention is needed at the Salcha River to address pipeline curvature.

In 1992, Alyeska made the first curvature measurements of TAPS with the smart pig. Curvature is a measure of the sharpness of bend in the pipe. It is a pipeline integrity concern because too much curvature can lead to buckling or wrinkling of the pipe, which weakens the pipe wall. The Salcha River crossing was an area of concern because the measured curvature exceeded the design basis critical curvature, which could cause the pipe to wrinkle.

This prompted JPO to obtain the services of Pacific Northwest National Laboratory (PNNL), operated by Battelle Laboratory of Columbus, Ohio, to look at the capacity and demand design for mainline pipe curvature. PNNL reviewed the methods Alyeska used to evaluate the structural integrity of TAPS. They also examined Alyeska's analysis methods, used to estimate the curvature capacity and the sensitivity of the smart pig, and data reduction methods for estimating curvature demand. Alyeska then completed a series of studies addressing PNNL's concerns.

How Did JPO Approach the Salcha River Issue?

Salcha River pipeline curvature was a significant concern in 1994 and 1995. For a time, data suggested the pipe may be moving, therefore increasing curvature. A consultant was brought in to help JPO evaluate curvature, in general. Once the pipe was determined to be static, the concern about Salcha River lessened. However, this study was planned in the *1998 Pipeline Operations CMP Work Plan* to follow through on this issue with the 1997 data. The focus on the design basis waiver illustrates how JPO resolves integrity and process questions.

Four zones of curvature at the Salcha River Crossing were addressed by the analysis, including an increase in curvature in one area between the 1993 and 1994 inspections with the smart pig. Battelle recommended that Alyeska send the smart pig through again to inspect for stability, and do a sensitivity analysis for online inspection methods that identify wrinkling. Alyeska sent the pig through the pipeline in April 1997. The resulting report concluded the curvature and ovality were stable at the Salcha River Crossing and had not changed. The curvature at the crossing showed no significant change from the 1994 inspection. Alyeska found no evidence of wrinkling and concluded the pipe does not require re-leveling under current operating conditions.

JPO reviewed the 1997 pig data and found no change in the data to require further action by Alyeska. However, a site-specific design basis waiver is needed, and Alyeska reports that it is being developed. Pipeline curvature analysis along the pipeline is an ongoing CMP operations initiative. JPO has curvature studies underway that will be presented in future CMP operations reports.

Pump Station Facility Settlement

- Facility settlement at a pump station is a noncompliance with the Grant and Lease, and Alyeska's design basis requirements. Alyeska developed a schedule for the corrective action plan, which JPO reviewed and accepted. After Alyeska has implemented their corrective action plan, they will be considered compliant with this stipulation.

Pump Stations 1 and 3 have experienced settlement of some building facilities from thawing of permafrost, due to an inability to maintain soil temperatures below freezing. Thawing of the permafrost foundation has occurred under some pump station buildings, resulting in partial settlement of the facilities. Facility settlement at a pump station is a noncompliance with stipulations 1.18.1 and 3.9 of the Grant and Lease, and Alyeska's design basis requirements. Alyeska had documented the settlement, and JPO surveillance verified it. JPO then requested Alyeska to use an appropriate quality tool to address the building settlement issues, and submit an annual action plan for the corrective work. In an October 1998 response to JPO, Alyeska laid out corrective actions for facility settlement at Pump Stations 1 and 3. Corrective action included a plan to initiate Project F016, a multi million dollar, two year project later this year to correct the settlement. Alyeska developed a schedule for the corrective action plan, which JPO reviewed

and accepted. After Alyeska has followed through with the implementation of their corrective action plan, they will be considered to be in compliance with this stipulation

Atigun Pass Heat Pipes

- Alyeska needs to complete its planned project to install thermistor strings at Atigun Pass.

Some heat pipes originally designed for the segment of insulated buried pipe at Atigun Pass, (pipeline milepost 167.2), are no longer functioning. Heat pipes are important because they maintain a consistent below ground temperature for buried pipe. In 1996, a consultant evaluated the adequacy of the remaining heat pipe configuration to prevent degradation of thaw unstable material. The consultant recommended the installation of three thermistor strings in this area. Thermistor strings are temperature measurement devices that monitor soil temperatures. Alyeska initiated a work order for the installation work with a projected completion date of September 30, 1998. However, the thermistor strings have not yet been installed, as of this printing. This segment of pipeline could be rendered indeterminate without a method of monitoring soil temperatures to measure effectiveness of existing heat pipes. Until these conditions are resolved or corrected, Alyeska is not in compliance with Stipulation 3.3, *Construction Mode Requirements*. JPO will conduct more surveillances in 1999, to evaluate the adequacy of the heat pipes and track the progress of the thermistor string installation.

Change Management

- Until Alyeska implements a functioning change management process, inconsistencies in critical operational instructions will continue to occur.

Change management, also referred to as configuration management, is an approach that provides for control of a system through disciplined management of all information pertaining to its configuration and operational requirements. Examples of this information are drawings, manuals, vendor documents, procedures, problem identification reports, survey data, and data sheets.

Deficiencies in change management accounted for approximately 40% of the 1993 Quality Technology Company audit findings, yet Alyeska still does not have an effective change management process. The recently released Alyeska assessment of the Alyeska Integrity Management System agrees with this conclusion. Alyeska committed to implementation of a functioning configuration management system as a requirement for closure of AAI 1955, which is the host AAI for issues regarding configuration management and TAPS determinacy. Determinacy refers to the assurance that the system is accurately described by existing records and is consistent with the final design and design basis.

Several sections of this report address incomplete revisions to operational procedures and other documentation problems associated with pump station ramp down efforts. Alyeska's internal audit group audited the ramp down projects for Pump Stations 8 and 10 to ensure all required ramp down procedures had been followed. The audit report stated:

> "The majority of configuration management deficiencies are attributable to lack of a corporate-level change management policy... The absence of a corporate management of change system for large projects, like ramp down, unnecessarily increased the risk of a safety or environmental upset during ramp down of Pump Stations 8 and 10."

Though the lack of a fully functional change management process had been identified following ramp down of Pump Stations 8 and 10, documentation problems continued to surface during subsequent ramp down projects for Pump Stations 2 and 6. This is cause for JPO concern. If the need arises to bring these pump stations back on line, a lack of current, accurate records increases the risk of a safety or environmental upset. Up-to-date modification records are a requirement of Stipulation 1.18.3, *Surveillance and Maintenance* and implementation of a controlled and effective system for documentation revisions is one of the cornerstones of configuration management. Until Alyeska incorporates an effective document revision process, changes made on TAPS will not be adequately represented, resulting in a state of indeterminacy.

JPO determined through assessment and surveillance that Alyeska does not currently have the ability to identify all the documentation affected by a change to an item or system. The two databases used to control documentation do not completely link system components with related drawings, documents, and procedures (the *Master Equipment List* in the *Passport* system and the *Technical Document and Drawing Index*). Alyeska committed to develop a systems-based physical item hierarchy with the capability to identify the data and documentation associated with a system or subsystem. This should mitigate document revision problems such as those encountered during ramp down.

A number of the issues identified in this report are related to delays in completing project commitments, which include revisions to affected documents. Modifications are frequently completed on a system, but the required documentation update work is backlogged rather than completed in a timely manner (reference Grant/Lease Stipulation 1.18.3, which requires completed and up-to-date modification records). Interviews conducted in support of JPO Assessment 98-A-009 indicated a strong perception on the part of TAPS workers that incomplete work efforts may be attributable to insufficient resources. Interviews with Alyeska employees further reveal that completion of work with less than full compliance to procedures, is often believed necessary in order to expedite the work load. Though regulatory oversight does not extend into specifying Alyeska's resource allocations, it does focus on assessing the results of those resource decisions. Grant and Lease Stipulation 1.21.1 requires that ...permittees shall perform all Pipeline System operations in a safe and workmanlike manner... and shall at all times employ and maintain personnel and equipment sufficient for that purpose. As discussed in Chapter Three, JPO will need to see significant and sustained improvement in this area before determining that Alyeska is in compliance with these two stipulations.

A critical element of successful configuration management is the development of: 1) methods for measuring the success of comprehensive program implementation, and 2) criteria for resource allocation decisions. Alyeska is moving toward implementation of these through corporate-wide performance standards in the revised Alyeska Integrity Management System program which should facilitate their ability to provide adequate resources for projects, project closeout, functional check-out, and turnover.

Chapter 3. Federal Grant and State Lease Compliance

- Five of the sixteen stipulations JPO evaluated were in noncompliance with the Grant and Lease. The noncompliances relate to change management and below ground systems deficiencies. The issues vary in significance, however none of them represent an immediate threat to pipeline integrity, public safety, or the environment. Alyeska has been informed all noncompliances must be corrected, and is working to bring them into compliance. JPO will evaluate progress and verify all completed corrections.

- The five stipulations containing aspects of noncompliance with the Grant and Lease include Surveillance and Monitoring, 1.18.1; Operation and Maintenance Records, 1.18.3; Conduct of Operations, 1.21; Construction Mode Requirements, 3.3; and Construction and Operation, 3.9.1. The noncompliances relate to the major discussion in this report: change management, pipeline control and telecommunication, and below ground systems.

Approach To Compliance: JPO pursues issues under the Grant and Lease proactively with Alyeska to maintain compliance, and uses the strategic approach of compliance partnership. This involves frequent communication, proactive problem resolution and a no surprises approach to achieve oversight objectives. These objectives include:

- Continued safe movement of oil through TAPS,
- Compliance with the Federal Grant and State Lease,
- Adequate spill and response capability,
- Reduction of TAPS risk by requiring knowledge of hardware condition, effective management controls, protection of the environment and worker safety.

Different aspects of the Grant and Lease stipulations evaluated here have previously been addressed in other CMP reports. Future reports will evaluate other aspects. The intent of this report is to discuss aspects of the stipulations that relate to pipeline operations, evaluated in 1998. Where instances of noncompliance were reported, this report does not imply that all other aspects of the stipulation were compliant. Instances of noncompliance do not have to be widespread or of long standing significance to be noted herein. JPO's view is that issues of noncompliance remain until corrected, but it is fair to say that none of the issues noted have required the Authorized Officer or State Pipeline Coordinator to issue a formal order to engage corrective action. All are believed to be correctable in the short term, with the exception of the change management issue and the fuel gas pipeline reburial.

The Grant and Lease stipulations were originally divided into three categories, General, Environmental and Technical. JPO evaluated all except two of the Technical stipulations, which will be included in future work planning. JPO also evaluated several stipulations from the General and Environmental categories as they relate to pipeline operations. The stipulations are discussed in the order in which they appear in the Grant and Lease.

General Stipulations

1.7 Notice to Proceed

A *Notice to Proceed* is the official document issued by the Authorized Officer giving Alyeska the permission to construct TAPS projects. Construction may not be initiated without the prior written permission of the Authorized Officer or State Pipeline Coordinator. A *Notice to Proceed* is required for some, but not all projects, according to Stipulation 1.7 of the Federal Agreement and Grant and State Lease of Right-of-Way. The Authorized Officer and State Pipeline Coordinator issue a notice to proceed when the design, construction and operation proposals conform with the provisions of the stipulations of the Grant and Lease. JPO determined that projects requiring a *Notice to Proceed* followed the Grant and Lease stipulations during

construction.

1.13 Electronically Operated Devices

Alyeska is required to screen, filter, or suppress devices that are installed as part of the pipeline system which are capable of producing electromagnetic interference radiation, so the devices will not adversely affect the existing communications systems or navigational aids. Structures such as towers or buildings that are erected as part of the pipeline system must not obstruct line-of-sight communication systems. JPO did a surveillance of this stipulation and verified that Alyeska is in compliance with the Grant and Lease. JPO will continue to monitor this stipulation as permits are issued for new installations.

1.15 Small Craft Passage

The Grant and Lease prohibit the creation of any permanent obstruction to the passage of small crafts in streams. While not directly related to this stipulation, JPO has observed some workpad bridges and pipeline river crossings have not been inspected, nor do they have the required permits. JPO will follow up on this situation and plans to conduct more surveillances in 1999 to make a complete and accurate compliance determination.

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1.18 Surveillance and Maintenance

Stipulation 1.18.1 requires the permittee to conduct a surveillance and maintenance program applicable to the subarctic and arctic environment. It should be designed to: 1) provide for public health and safety, 2) prevent damage to natural resources, 3) prevent erosion, and 4) maintain pipeline system integrity. Two issues reflect noncompliance with this stipulation: 1) the need to rebury exposed parts of a fuel gas line as a result of ground upheaval, and 2) the facility settlement at Pump Stations 1 and 3. (The pump station facility settlement issue was discussed on page 26). JPO requested Alyeska to submit an annual fuel gas line corrective action plan that includes a schedule of the specific work to be completed for the year; and also requested Alyeska to rebury all fuel gas pipeline exposures in compliance with the minimal depth of cover per Department of Transportation regulations. Alyeska will be considered compliant with this stipulation after they have implemented their corrective action plan.

Fuel Gas Line

JPO's 1998 surveillance of the fuel gas line indicated locations where standing or flowing water crosses the gas line and thermokarsting, or ground upheaval buckling exists. The fuel gas pipeline supplies Pump Stations 1, 3, and 4 with fuel gas from the ARCO Central Compressor Plant. The control center for the fuel gas line is located at Pump Station 1. The ground upheaval conditions resulted in the reduction of the fuel gas line insulation cover between Pipeline Milepost 12-18, exposing the pipe in some areas. Exposed gas line pipe does not meet either Department of Transportation regulations or design basis requirements. Alyeska proposed corrective action, which is acceptable to JPO. However, until corrected, it represents an instance of noncompliance, since Alyeska's surveillance and maintenance processes did not prevent this situation.

Stipulation 1.18.2 requires a communication system that ensures the transmission of information necessary for the safe operation of the pipeline. The fiber optics project, when completed, should improve the system that was judged acceptable under this stipulation at start up.

Stipulation 1.18.3 requires maintaining complete and up-to-date records on operations activities. This stipulation specifically references modification records. Evidence from JPO surveillances as well as Alyeska's quality assurance activities demonstrates that modification records are not timely updated. The lack of timely records update is a symptom of the change or configuration

management deficiencies discussed in Chapter 2, and constitutes a noncompliance with this stipulation.

Stipulation 1.18.4 involves access roads and airstrips, and was not completely evaluated this year. However, JPO does not have reason to believe Alyeska is not in compliance. This stipulation is broad in scope and relates to more than operations-related issues. Other aspects of this stipulation, including work pad maintenance and slope stability will be covered in the *CMP Maintenance Report*, planned for release early in 1999.

1.19 Housing and Quarters

This stipulation involves provision of reasonable housing, quarters, office space and transportation for representatives of the Authorized Officer and the State Pipeline Coordinator. In the judgement of the Authorized Officer and the State Pipeline Coordinator, Alyeska is in compliance with this stipulation.

1.21 Conduct of Operations

Most of the findings JPO identified through surveillances and assessments conducted within the last year were related to this stipulation, which states:

> "...the permittee shall perform all pipeline system operations in a safe and workmanlike manner so as to ensure the safety and integrity of the pipeline system, and shall at all times employ and maintain personnel and equipment sufficient for that purpose."

The issues preventing a finding of compliance stem from inattention to procedural requirements and poor management of change rather than direct threats to system integrity or safety. The thirty unsatisfactory conditions discussed in Chapter Two regarding managing and documenting pressure control set points have been resolved. The change management issues previously discussed are inconsistent with operating the system in a safe and workmanlike manner. Alyeska is considered to be in noncompliance under this stipulation until the change management issue is resolved. Start up problems were also presenting a pattern of procedure and planning deficiencies that could have risen to noncompliance if recent start ups had not evidenced improvement. Overall, the compliance issues with this stipulation are the most significant issues raised in this CMP report.

This stipulation also requires immediate notification of the Authorized Officer and State Pipeline Coordinator of any condition, malfunction, problem or occurrence which threatens pipeline integrity. Alyeska and JPO have agreed upon a reporting protocol which Alyeska has followed.

Environmental Stipulations

2.11 Use of Explosives

The Grant and Lease state that a plan must be submitted to the Authorized Officer and the State Pipeline Coordinator for use of explosives, including, but not limited to blasting techniques in accordance with Stipulation 1.7. JPO conducted a surveillance that verified no recent blasting has occurred within the 3,000 foot corridor of the pipeline right-of-way, as referenced in Alyeska's blasting requirements. To the extent this stipulation was surveilled, Alyeska was found to be in compliance with the Grant and Lease. If future projects require blasting, JPO will

monitor and evaluate Alyeska's compliance with the Grant and Lease.

2.14 Contingency Plans

This stipulation states that no discharge of oil or other pollutant should occur on land or water. Permittees must recognize their prime responsibility for the protection of the public and the environment from the effects of spillage. JPO previously stated in the CMP Report*, Alyeska Pipeline Service Company TAPS Environmental Protection Program*, March 1998:

> Oil spill contingency plans (C-Plans) are required by the Grant, Lease, and State and Federal laws. There are separate C-Plans for the Valdez Marine Terminal (VMT) and the pipeline. The range of issues covered by each C-Plan includes spill prevention, preparedness, and response requirements. The VMT C-Plan was conditionally approved by JPO agencies in January 1997. C-Plans are reviewed by State and Federal agencies every three to five years. The Grant and Lease require that the Bureau of Land Management and Alaska Department of Natural Resources review the C-Plans annually. The eleven conditions of approval for the Terminal C-Plan include a range of requirements such as further planning for shoreline protection in Port Valdez and maintenance of secondary containment structures around the terminal crude oil storage tanks. Many conditions of approval were to be addressed in 1998.

Of the remaining conditions of approval that awaited completion in 1998, four conditions are awaiting additional public review: 1) preventing or controlling a potential fire hazard, 2) slope stability, 3) shoreline protection, and 4) protection of the Valdez Duck Flats and Solomon Gulch Hatchery. A condition regarding oil storage tank secondary containment structures and a condition on prevention training programs also remain open. All others have been completed.

In addition to the progress made in resolving the conditions of approval for the Valdez Marine Terminal C-Plan during 1998, the C-Plan for the pipeline was reviewed and approved. The Pipeline C-Plan approval also has conditions that JPO will oversee, including an examination of response options near tributaries to the Copper River, including the Gulkana River. During 1998, JPO looked at traditional areas for spill preparedness, completed at least three surveillances of oil spill equipment inventories and two surveillances of spill response training exercises. There were no problems found in either area. Alyeska is in compliance with this stipulation. However, this compliance determination is subject to Alyeska meeting the C-Plan approval conditions and commitments.

Technical Stipulations

3.2 Pipeline System Standards

This stipulation requires that all design, material and construction, operation, maintenance and termination practices employed in the pipeline system will be done according to pipeline standards described by the stipulation. JPO conducted surveillances to verify that materials and design met appropriate codes and specifications. A surveillance at the Valdez Marine Terminal indicated undersized material that did not meet specifications was used on the face of the avalanche berm. However, this unsatisfactory condition was minor in nature. JPO's overall conclusion was that Alyeska has complied with the Grant and Lease requirements concerning this stipulation.

3.3 Construction Mode Requirements

This stipulation specifies the criteria for selecting the construction mode of above ground and buried pipe and contains a suite of requirements including soil conditions and heat transfer. As mentioned in Chapter Two, JPO's field surveillance indicated some of the heat pipes originally designed for the insulated buried pipe in Atigun Pass, were no longer functioning. (Heat pipes maintain a consistent below ground temperature for buried pipe). Alyeska plans to measure the effectiveness of existing heat pipes, using data acquired from thermistor strings which have not yet been installed. Until these conditions are resolved or corrected, Alyeska is not in compliance with stipulation requirements. JPO will conduct more surveillances later this year to evaluate the adequacy of Atigun Pass heat pipes, and track the progress of the thermistor string installation.

3.4 Earthquakes and Fault Displacements

The pipeline system is required to be designed to prevent any oil leakage from the effects of earthquakes, including seismic shaking, ground deformations, and earthquake-induced mass movements. Where such design is not technically feasible, efforts to minimize damage must include ground motion detectors, rapidly programmed shutdown and close inspection of system integrity if ground motion reaches the operational design level. A special contingency plan for oil spill control must also be in place, according to Stipulation 2.14.

JPO approved a November 26, 1997 request from Alyeska for a temporary waiver of Grant and Lease Stipulation 3.4.1.2. Alyeska requested approval to remove the existing Earthquake Monitoring System (EMS) from service so they could install new EMS equipment. Equipment was installed and the system restored to full operating status after testing, calibration, and a functional check out of the new equipment was completed (*see Appendix VI photos*).

In January 1998, JPO did an assessment to evaluate the overall effectiveness of Alyeska's Earthquake Monitoring System. JPO concluded the system is capable of providing information to the Operations Control Center in Valdez, should a major seismic event occur. Seismic units, or digital strong motion accelerographs, are located at all pump stations (except Pump Stations 2 and 3) and at the Valdez Marine Terminal. The units detect seismic activity from light tremors to severe earthquakes. Seismic information is fed directly to the SCADA system and transmitted to Valdez via a separate telecommunications channel. Data is then transmitted to the Operations Control Center and acquires information from the seismic units in the area of the earthquake.

Alyeska assigned EMS responsibility to their operations section. Fault monitoring is no longer conducted on an annual basis. Instead, Alyeska conducts annual site inspections of permanent reference marks, called fault monitoring monuments to: 1) check for damage or disturbance, 2) ensure that all monuments are well marked and protected from human and wildlife disturbance, and 3) provide a survey of monitoring points after a major seismic event. JPO found all the monuments were visible, although some required maintenance due to wildlife disturbance. JPO verified Alyeska conducted surveys and engineering surveillances as required by their *Surveillance and Monitoring Manual* and *System Integrity Monitoring Program.* Alyeska is in compliance with the Grant and Lease requirements concerning this stipulation. JPO will continue to track the performance of the earthquake monitoring system for TAPS.

3.6 Stream and Flood Plain Crossings and Erosion

The pipeline must be designed to withstand or accommodate the effects of meteorologic, hydrologic (surface and sub-surface), and hydraulic conditions considered reasonably passable

for each region the pipeline passes through. These effects and conditions include runoff, stream and flood plain erosion, meander cutoffs, lateral migration, ice jams and icing. Alyeska conducts an annual engineering surveillance to observe and document changes in river environments that may affect TAPS. JPO reviewed Alyeska's *River and Flood Plain Monitoring Summary Report* that verified compliance with this stipulation.

3.7 Sea Waves

The Grant and Lease require that oil transfer facilities at the Valdez Marine Terminal be protected by devices designed to cut oil flow and prevent major leaks in the event of destructive sea waves such as those generated in Port Valdez by the March 27, 1964 earthquake. JPO conducted a surveillance to verify that quick disconnect couplings are used at the marine tanker loading arms, quick shut-off valves can be remotely controlled from the Operations Control Center, and shut-off valves are installed at the main manifold at the dock and each tank in the tank farm. The automatic controls regulate oil flow rates and prevent excessive surge pressures. The system ensures safety for all normal operations and permits shutdown at all of these locations in event of emergency. The seabed at the Terminal docks consists of steeply sloping rock, with a soft overburden up to 30 feet deep. The docks are anchored directly to the bedrock. JPO determined that Alyeska complies with the Grant and Lease requirements for this stipulation. To maintain compliance with this stipulation, Alyeska decided to insert a specific reference to this stipulation in appropriate manuals. JPO supports this decision.

3.8 Glacier Surges

The Grant and Lease require the installation of surveillance systems to provide adequate warning of impending glacier surges that could potentially damage the pipeline system. JPO did an assessment to evaluate Alyeska's glacier monitoring procedures to determine the effectiveness of the surveillance systems to adequately warn of impending glacier surges. The assessment concluded Alyeska monitors and evaluates glacier movement, as required by Grant and Lease Stipulation 3.8, and Alyeska's manuals and documents. Alyeska has not documented any significant glacier movement, so at present glacier surges are not a threat to the pipeline.

The *System Integrity Monitoring Program Procedures Manual* (MP-166) requires aerial photographs be taken every five years, to analyze and identify trends in glacier movement. The photos will also identify if maintenance of the right-of-way is required, and whether to adjust the frequency of glacier monitoring as described in MP-166. Alyeska is in compliance with the Grant and Lease requirements for this stipulation, and is considering inserting additional protective contingency measures to their manuals.

3.9 Construction and Operation

The Grant and Lease require all activities performed in connection with the pipeline system to be conducted to avoid or minimize thermal and other environmental changes and to provide protection to people, fish and wildlife habitat. All working platforms, pads, fills and other surface modifications are to be planned and executed in such a way that any resulting degradation of permafrost will not jeopardize the pipeline or related facility foundations. This stipulation relates to Stipulation 1.18, *Surveillance and Maintenance*, where JPO noted a noncompliant condition due to facility settlement. Alyeska and JPO are presently working toward resolution of this issue. JPO recommended that Alyeska initiate a corrective action plan to address the facility settlement at Pump Stations 1 and 3. This problem must be corrected for

Alyeska to be compliant with this stipulation.

3.11 Containment of Oil Spills

This stipulation requires the installation of oil spill containment dikes or other structures around storage tanks at pump stations, the Valdez Marine Terminal, and at critical locations along the pipeline system. Structures must be constructed to withstand earthquake failure and to provide storage of oil to prevent drainage or seepage until the contents can be disposed of safely. JPO did surveillances to verify that containment areas be constructed to contain sufficient volume of the tanks within the containment areas, and checked to make sure containment areas were routinely examined for cracks and seepage. Alyeska complied with the Grant and Lease for the attributes JPO checked during field surveillance. JPO plans to do more surveillances in 1999 to gather more information to determine compliance with all the criteria of this stipulation.

Chapter 4. The Employee Concerns Program and Audit Item Resolution

- Alyeska processed and closed two substantiated employee concerns related to operations in 1997-1998. JPO reorganized its employee concerns oversight to better trend and evaluate the concerns of TAPS workers.

Alyeska's Employee Concerns Resolution Program

An employee concern is a statement or assertion of impropriety or inadequacy associated with the construction, operation, maintenance or management of TAPS and affects the quality, safety, environmental protection, and pipeline integrity of TAPS. A critical focus of JPO's oversight is to ensure that employees of Alyeska Pipeline Service Company or employees of Alyeska's contractors can voice their concerns about technical and business practices in an atmosphere which promotes free and open communications.

Alyeska established the employee concerns program to investigate, resolve and document employee concerns that were not otherwise being resolved. The program is available to all people working on TAPS, including Alyeska and contractor employees and other interested persons. Alyeska has made available several avenues for the expression of employee concerns. Employee concerns should be promptly investigated to gather and analyze facts to determine a course of future action. The Joint Pipeline Office has a toll-free telephone hotline for anonymous reporting of concerns. JPO staff has an Employee Concerns Specialist to assist workers in resolving concerns and provides information and guidance on available resources. JPO recently reorganized its Employee Concerns office, increased staff and placed a new emphasis on the trending of concerns.

Employee Concerns Relating To Operations

JPO reviewed two operations-related employee concerns filed with Alyeska between June 1, 1997 and September 30, 1998. Both concerns were substantiated.

The first concern was filed in July 1997. The concern raised an issue of a security guard employed by a contractor working on Alyeska facilities who had violated the *Amendments to the Gun Control Act* of 1968. The individual was not authorized to be an armed guard due to the prior conviction under the Act. This was an operations-related concern because it involved pump station security personnel. An investigation substantiated the concern and the security guard in question was reassigned to duties that did not require a firearm be carried. This concern was closed September 1997.

The second concern was filed in December 1997. This concern alleged Alyeska violated their own procedure by granting conditional approval for a contractor to be on the Quality Suppliers List. The contractor was granted two 120-day extensions in addition to the original conditional approval time of 120 days, because the Quality Program requirements were not met for placing personnel on the Quality Suppliers List. This concern was validated through an internal Alyeska investigation. As a result, Alyeska took corrective action by revising their Quality Program *Principal Implementing Procedures*. This concern was closed in January 1998.

Audit Action Item Resolution

- Alyeska closed many operations-related audit action items in 1996 and 1997. Presently, five audit items remain open that are planned for completion later this year. However, several items that should significantly improve operations have not yet been closed. Operational deficiencies such as ineffective change management continue to exist, which will, if uncorrected, cause the repeat of many 1993 audit deficiencies. The audit items including change management will not be closed until an effective change management system is in place.

TAPS Audits

In 1993, BLM contracted with Quality Technology Company to conduct an audit of TAPS operations and maintenance. This audit, which was inspired by testimony of TAPS whistle blowers at Congressional oversight hearings, uncovered numerous systemic deficiencies including:

- An ineffective Alyeska quality program;
- Questionable electric code compliance; and
- A pipeline that, after 17 years of accumulative modifications, could no longer be shown to be able to withstand major earthquakes or other possible contingencies.

The TAPS Owners and Alyeska Pipeline Service Company contracted with Arthur D. Little in 1993 to do an independent assessment of the entire pipeline, which essentially validated the BLM audit. The audit identified several more deficiencies. Most of the problems occurred inside the fences of the pump stations and the Valdez Marine Terminal rather than along the pipeline itself, where JPO had previously placed monitoring focus. Similarly, few of these deficiencies were environment related or involved the oil spill contingency plan, two key areas of JPO emphasis.

As a result of these audits, Alyeska identified 4,920 audit action items. As of January 4, 1998, 54 items remained to be completed. Presently, 5 audit action items remain open and should be completed later this year.

Pipeline Hydraulic Model

The Joint Pipeline Office believes Alyeska has complied with the commitments made in 1995 to close audit findings regarding the hydraulic model.

Qualification and Development Program (QDP) for Pipeline Controllers and Operators

The qualification and development program initiated during 1994 was a result of the 1992 owners safety audit, the BLM audit and the TAPS assessment addressing technician capabilities. A one-year pilot program for OCC operators was started in the Valdez Operations Control Center in late 1995. A site-specific program for the pump station control rooms was initiated in August 1996. Full implementation of these two programs closed ten AAI's, with a single audit item remaining. This is scheduled for closure in 1999. The QDP will be fully implemented when the qualification instruments (QI) are validated and entered in Alyeska's training administration system, all appropriate team members are qualified on designated core QI's, and all components of the program are complete and records on file, including team qualification plans and business plans.

The TAPS Leak Detection System

The leak detection system on TAPS consists of a uniquely designed line-wide metering system with several components to measure net oil flow in and out of each pump station. These leading edge flow meters use ultrasonic sound pulses and transit time to measure precise flow, and flow

rate. Data from these units are passed to the Supervisory Control And Data Acquisition (SCADA) system for transmission to the Operations Control Center in Valdez. These data are used in leak calculations and for the continuous monitoring of pipeline status by the pipeline controller. JPO conducted surveillances that verified the installation of new flow meters, closing an audit action item in April 1998.

Seismic Monitoring System

Seismic units known as digital strong motion accelerographs, are located at all pump stations except Pump Stations 2 and 3. These units detect earth movements caused by earthquakes. Information from the seismic units are transmitted to the SCADA System in Valdez by a separate telecommunications channel. JPO did a surveillance to verify the accelerographs had been installed at Pump Stations 1 and 4, where they had been previously removed. JPO verified the installation and start up of the new system at different locations. This resulted in the closure of an audit action item. Additionally, JPO verified that equipment located in the pump stations and control rooms were secured to prevent movement and damage in a seismic event. This resulted in closure of several audit items related to the seismic monitoring system.

Supervisory Control and Data Acquisition System

The age and maintenance of the Supervisory Control and Data Acquisition (SCADA) system and communication equipment required an upgrade and replacement of equipment. Alyeska developed a long range plan to modernize the SCADA system. This closed an audit action item. Another audit item was closed, involving the replacement of components and the inventorying of adequate spare parts.

Seismic Cable Tray Supports

Audit Action Item No. 10011 was designated as the host closure package for the seismic cable tray support issues. The evaluation phase addressed all of the cable tray concerns, as well as other related audit compliance tracking and closure items. The evaluation detailed written procedures for engineering evaluation; qualification of TAPS cable trays to specify the applicable seismic criteria; drawings of modifications to be made, and engineering screening and a walkdown process to identify supports or tray spans that are potentially overloaded. JPO verified the completion of the seismic cable tray work at the Valdez Marine Terminal in September 1998, which closed this audit item.

Chapter 5. Future JPO Work Commitment

JPO will continue to monitor a large variety of TAPS operations functions and operational requirements during 1999. Future oversight of pipeline system operations and other related areas will focus on:

Grant and Lease Compliance

JPO will monitor the identified instances of noncompliance to verify that corrections have been made. The compliance monitoring contained in this report was not intended to be a complete report card, but rather to initiate corrective action in those aspects where JPO found noncompliances. Grant and Lease compliance will constitute an increasing component of oversight and CMP reporting in preparation for Grant and Lease renewal before the year 2004.

Audit Action Items

Alyeska's change management ineffectiveness contributed to a large percentage of the 1993 audit action items. JPO's recent approval of Alyeska's revision to their quality program is intended to prevent recurrence of audit deficiencies. JPO's 1999 monitoring will include collection of the necessary information to report on the effectiveness of Alyeska's efforts and identify any noncompliance with the Federal Grant and State Lease.

Causal Factor Analysis

JPO will evaluate the adequacy of the causal factor analysis process to determine the root cause of incidents, to ensure Alyeska has a process to track and trend these incidents.

Qualification and Development Program and Controller Training

JPO will verify the full implementation of the Qualification and Development Program, and will also further investigate the adequacy of training of controllers or provision of information to controllers regarding changes in system configuration, both temporary and permanent.

Leak Detection System

JPO will continue oversight to determine whether the leak detection system is performing as designed, and to encourage Alyeska to explore NASA's Jet Propulsion Lab technologies in developing better leak detection sensors.

Instrumentation

JPO will continue to monitor critical process instrumentation pressure control set points as referenced in *DO-14, Trans-Alaska Pipeline Controller Manual*.

Fiber Optics Cable Project

JPO will monitor the fiber optics cable communication project to ensure TAPS safety and operational reliability. Later this year, JPO will decide on the issuance of a Notice to Proceed for the project, to allow control of valves using the fiber optics system.

Shutdowns and Re-starts

JPO will closely monitor start up conditions after planned shutdowns have occurred, to evaluate Alyeska's performance and adherence to procedural controls and safeguards, and determine if changes to operating procedures are controlled through the use of an effective document control system.

Cold Re-start Plan

JPO will continue to monitor Alyeska's progress for completion of the necessary studies before initiating a cold re-start plan for starting the pipeline under extreme weather conditions.

Pipeline Hydraulic Model

JPO will verify the models are updated and manuals and documents are revised and distributed as promised.

Pipeline Overpressure Events

JPO will continue to monitor Alyeska's improvements in handling potential overpressure events. JPO recently obtained the pipeline pig data and is currently evaluating it to verify Alyeska's conclusion that pipeline integrity was not affected.

Alyeska's Progress on Y2K

JPO will continue to monitor Alyeska's Y2K compliance efforts, and stay informed of any circumstances which could hinder Alyeska's ability to successfully meet Y2K requirements.

Mainline Refrigeration Unit No. 2 (MLR-2)

Monitoring of MLR-2 will continue for 1999, to ensure pipeline integrity is protected.

Closing Summary

Alyeska's noncompliance with some aspects of the Grant and Lease do not constitute an immediate threat to pipeline integrity, public safety, or the environment. As stated earlier, the issues vary in significance. JPO's future work plans will include the necessary monitoring to ensure these deficiencies are corrected.

JPO believes that Alyeska needs to pay greater attention to detail, do more thorough trending and evaluation of incidents, and comply more rigorously with their own procedures. Alyeska's own quality assurance audits and reviews have recognized this and corrective action is underway.

Change management of TAPS critical systems and components is ineffective, and Alyeska agreed with this conclusion in their *Internal Assessment Report* (September 1998). In the upcoming year, JPO will assess Alyeska and contractors application of quality program controls and Alyeska Integrity Management System principles to ensure effective management of changes to critical TAPS systems and components.